SPINOUTS

News from the Technology Transfer Program

It is only fitting that this inaugural column from NSA's Technology Transfer Program (TTP) appears in an edition of *The Next Wave* focusing on intellectual property and technology transfer. Within this space, the TTP will be bringing you interesting and informative topics within technology transfer, intellectual property marketing, and new patents, as well as transfer success stories. For our first column, we will be discussing Technology Readiness Levels, or TRLs.

Technology Readiness Levels (TRLs) are a scale used by industry and government to determine the maturity of technologies to be incorporated into another type of system. In NSA's TTP, TRLs are used informally when evaluating technologies for transfer. Generally, the higher the TRL, the more likely the technology will successfully transfer to a commercial environment.

Although TRLs were originally conceived at NASA in the 1970's, similar but different definitions are now used by various agencies, including the US Department of Defense (DoD). The following definitions are taken from the DoD 2011 Technology Readiness Assessment Guidance, prepared by the Assistant Secretary of Defense for Research and Engineering.

- **TRL 1. Basic principles observed and reported.** This is the lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
- **TRL 2. Technology concept or application formulated.** Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
- **TRL 3. Analytical and experimental critical function and/or characteristic proof of concept.** Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
- **TRL 4. Component validation in a laboratory environment.** Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
- **TRL 5. Component validation in a relevant environment.** Fidelity of technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high-fidelity" laboratory integration of components.
- **TRL 6. System/subsystem model or prototype demonstration in a relevant environment.** Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. This level represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
- **TRL 7. System prototype demonstration in an operational environment.** Prototype near or at planned operational system. This level represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).
- **TRL 8. Actual system completed and qualified through test and demonstration.** Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
- **TRL 9. Actual system proven through successful mission operations.** Actual application of the technology in its final form and under mission conditions takes place, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.